

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1-5. (Cancelled)

6. (Currently Amended) A method for producing a semiconductor device having a cylindrical storage node comprising a bottom portion and a cylindrical portion which surrounds an outer circumference of said bottom portion and extends upward, which comprises the steps of:

forming a contact hole which penetrates an interlayer insulating film formed on a semiconductor substrate;

forming an electric conductive film on said interlayer insulating film whereby said contact hole is filled to obtain a contact to said substrate;

forming an insulating film on said electric conductive film;

patterning by an anisotropic etching said insulating film and said electric conductive film to form a configuration corresponding to said cylindrical portion so that a core and the bottom portion of said cylindrical portion are formed;

forming the cylindrical portion on the side of said core and said bottom portion wherein an outer wall of said cylindrical portion is roughened, comprising the sequential steps of forming a film ~~[[containing]]~~ made of amorphous silicon on said core and said bottom portion; roughening an outer surface of said film ~~containing silicon~~ by forming silicon grains in the outer surface of it; and conducting an anisotropic etching for patterning to form said cylindrical portion having a side-wall like shape at the side of said core and said bottom portion;

removing said core;

forming a dielectric film to cover said cylindrical storage node comprising said cylindrical portion and said bottom portion; and

forming a cell plate on said dielectric film, whereby a capacitor constituted by said cylindrical storage node, said dielectric film and said cell plate is formed,

wherein said method for producing a semiconductor device is performed such that the inner wall of the cylindrical portion having the roughened outer wall remains in a form of said amorphous silicon.

7. (Currently Amended) A method for producing a semiconductor device having a cylindrical storage node comprising a bottom portion and a cylindrical portion which surrounds an outer circumference of said bottom portion and extends upward, which comprises the steps of:

forming a contact hole which penetrates an interlayer insulating film formed on a semiconductor substrate;

forming an electric conductive film on said interlayer insulating film whereby said contact hole is filled to obtain a contact to said substrate;

forming an insulating film on said electric conductive film;

patterning by an anisotropic etching said insulating film and said electric conductive film to form a configuration corresponding to said cylindrical portion so that a core and the bottom portion of said cylindrical portion are formed;

forming the cylindrical portion on the side of said core and said bottom portion wherein an outer wall of said cylindrical portion is roughened, comprising forming [[an]] a film made of amorphous silicon [[film]] on said core and said bottom portion; conducting an anisotropic

etching of said ~~amorphous silicon~~ film to form said cylindrical portion having a side-wall like shape at the side of said core and said bottom portion; and roughening said outer wall of said cylindrical portion by forming silicon grains;

removing said core;

forming a dielectric film to cover said cylindrical storage node comprising said cylindrical portion and said bottom portion; and

forming a cell plate on said dielectric film, whereby a capacitor constituted by said cylindrical storage node, said dielectric film and said cell plate is formed,

wherein said method for producing a semiconductor device is performed such that the inner wall of the cylindrical portion having the roughened outer wall remains in a form of said amorphous silicon

8. (Currently Amended) [[A]] The method for producing a semiconductor device according to Claim 6, wherein the roughening of the outer surface of the film ~~containing silicon~~ is selected from the group consisting of a heat treatment with use of silane and a heat treatment in vacuum after a treatment to the outer surface of said film ~~containing silicon~~ with use of hydrofluoric acid, whereby projections and recesses are formed in the outer surface of said film ~~containing silicon~~ by forming silicon grains in the outer surface.

9. (Currently Amended) [[A]] The method for producing a semiconductor device according to claim 7, wherein the roughening of the outer wall of the cylindrical portion is selected from the group consisting of a heat treatment with use of silane and a heat treatment in vacuum after a treatment to the outer wall of said cylindrical portion with use of hydrofluoric

acid, whereby projections and recesses are formed in the outer wall of said cylindrical portion by forming silicon grains in the outer wall.

10-12. (Cancelled)

13. (Currently Amended) A method for producing a semiconductor device ~~according to Claim 12,~~ having a cylindrical storage node comprising a bottom portion and a cylindrical portion which surrounds an outer circumference of said bottom portion and extends upward, which comprises steps of:

forming a contact hole which penetrates an interlayer insulating film formed on a semiconductor substrate;

forming an electric conductive film on said interlayer insulating film whereby said contact hole is filled to obtain a contact to said substrate;

forming an insulating film on said electric conductive film;

patterning by an anisotropic etching said insulating film and said electric conductive film to form a configuration corresponding to said cylindrical portion so that a core and the bottom portion of said cylindrical portion are formed;

forming the cylindrical portion on the side of said core and said bottom portion wherein an outer wall of said cylindrical portion is roughened, ~~wherein the step of forming the cylindrical portion on the side of the core and the bottom portion wherein the outer wall of the cylindrical portion is roughened, comprises~~ comprising the steps of forming a film made of [[an]] amorphous silicon [[film]] on said core and said bottom portion; roughening an outer surface of said ~~amorphous silicon~~ film by forming silicon grains in the outer surface of it; and conducting

an anisotropic etching for patterning to form said cylindrical portion having a side-wall like shape at the side of said core and said bottom portion,

forming a dielectric film on said cylindrical storage node comprising said cylindrical portion and said bottom portion within which said core remains; and

forming a cell plate on said dielectric film, whereby a capacitor constituted by said cylindrical storage node, said dielectric film and said cell plate is formed,

wherein said method for producing a semiconductor device is performed such that the inner wall of the cylindrical portion having the roughened outer wall remains in a form of said amorphous silicon.

14. (Currently Amended) A method for producing a semiconductor device ~~according to Claim 12,~~ having a cylindrical storage node comprising a bottom portion and a cylindrical portion which surrounds an outer circumference of said bottom portion and extends upward, which comprises steps of:

forming a contact hole which penetrates an interlayer insulating film formed on a semiconductor substrate;

forming an electric conductive film on said interlayer insulating film whereby said contact hole is filled to obtain a contact to said substrate;

forming an insulating film on said electric conductive film;

patterning by an anisotropic etching said insulating film and said electric conductive film to form a configuration corresponding to said cylindrical portion so that a core and the bottom portion of said cylindrical portion are formed;

forming the cylindrical portion on the side of said core and said bottom portion wherein an outer wall of said cylindrical portion is roughened, wherein the step of forming the cylindrical portion on the core and the bottom portion wherein the outer wall of the cylindrical portion is roughened, comprises comprising the steps of forming a film made of [[an]] amorphous silicon [[film]] on said core and said bottom portion; conducting an anisotropic etching of said amorphous silicon film to form said cylindrical portion having a side-wall like shape at the side of said core and said bottom portion; and roughening said outer wall of said cylindrical portion by forming silicon grains,

forming a dielectric film on said cylindrical storage node comprising said cylindrical portion and said bottom portion within which said core remains; and

forming a cell plate on said dielectric film, whereby a capacitor constituted by said cylindrical storage node, said dielectric film and said cell plate is formed,

wherein said method for producing a semiconductor device is performed such that the inner wall of the cylindrical portion having the roughened outer wall remains in a form of said amorphous silicon.

15. (Currently Amended) [[A]] The method for producing a semiconductor device according to claim 13, wherein the roughening of the outer surface of the ~~amorphous silicon~~ film is selected from the group consisting of a heat treatment with use of silane and a heat treatment in vacuum after a treatment to the outer surface of said ~~amorphous silicon~~ film with use of hydrofluoric acid, whereby projections and recesses are formed in the outer surface of said ~~amorphous silicon~~ film by forming silicon grains in the outer surface.

16. (Currently Amended) ~~[[A]]~~ The method for producing a semiconductor device according to claim 14, wherein the roughening of the outer wall of said cylindrical portion is selected from the group consisting of a heat treatment with use of silane and a heat treatment in vacuum after a treatment to the outer wall of said cylindrical portion with use of hydrofluoric acid, whereby projections and recesses are formed in the outer wall of said cylindrical portion by forming silicon grains in the outer wall.

17-18. (Cancelled)

19. (Currently Amended) A method for producing a semiconductor device having a cylindrical storage node comprising a bottom portion and a cylindrical portion which surrounds an outer circumference of said bottom portion and extends upward, which comprises the steps of:

forming a contact hole which penetrates an interlayer insulating film formed on a semiconductor substrate;

forming an electric conductive film on said interlayer insulating film whereby said contact hole is filled to obtain a contact to said substrate;

forming an insulating film on said electric conductive film;

patterning by an anisotropic etching said insulating film and said electric conductive film to form a configuration corresponding to said cylindrical portion so that a core and the bottom portion of said cylindrical portion are formed;

forming the cylindrical portion on the side of said core and said bottom portion wherein an outer wall of said cylindrical portion is roughened, comprising the ~~[[sequential]]~~ steps of forming a film ~~[[containing]]~~ made of amorphous silicon on said core and said bottom portion;

roughening an outer surface of said film ~~containing silicon~~ by forming silicon grains in the outer surface of it; and conducting an anisotropic etching for patterning to form said cylindrical portion having a side-wall like shape at the side of said core and said bottom portion;

removing said core;

forming a dielectric film to cover said cylindrical storage node comprising said cylindrical portion and said bottom portion; and

forming a cell plate on said dielectric film, whereby a capacitor constituted by said cylindrical storage node, said dielectric film and said cell plate is formed,

wherein said method for producing a semiconductor device is performed such that the inner wall of the cylindrical portion having the roughened outer wall remains in a form of said amorphous silicon.

20. (Currently Amended) [[A]] The method for producing a semiconductor device according to Claim 7, wherein the anisotropic etching of said amorphous silicon is conducted so as to cover whole circumferential areas of said core and said bottom portion by said cylindrical portion, and whole the outer wall of the cylindrical portion covering the whole circumferential areas of said core and said bottom portion is roughened.

21. (Currently Amended) A method for producing a semiconductor device having a cylindrical storage node comprising a bottom portion and a cylindrical portion which surrounds an outer circumference of said bottom portion and extends upward, which comprises the steps of:

forming a contact hole which penetrates an interlayer insulating film formed on a semiconductor substrate;



forming an electric conductive film on said interlayer insulating film whereby said contact hole is filled to obtain a contact to said substrate;

forming an insulating film on said electric conductive film;

patterning by an anisotropic etching said insulating film and said electric conductive film to form a configuration corresponding to said cylindrical portion so that a core and the bottom portion of said cylindrical portion are formed;

forming the cylindrical portion on the side of said core and said bottom portion wherein an outer wall of said cylindrical portion is roughened, comprising forming a film made of [[an]] amorphous silicon [[film]] on said core and said bottom portion; conducting an anisotropic etching of said ~~amorphous silicon~~ film to form said cylindrical portion having a side-wall like shape at the side of said core and said bottom portion so as to cover whole circumferential areas of said core and said bottom portion by said cylindrical portion; and roughening whole said outer wall of said cylindrical portion covering the whole circumferential areas of said core and said bottom portion by forming silicon grains;

removing said core;

forming a dielectric film to cover said cylindrical storage node comprising said cylindrical portion and said bottom portion; and

forming a cell plate on said dielectric film, whereby a capacitor constituted by said cylindrical storage node, said dielectric film and said cell plate is formed,

wherein said method for producing a semiconductor device is performed such that the inner wall of the cylindrical portion having the roughened outer wall remains in a form of said amorphous silicon.

22. (Currently Amended) ~~[[A]]~~ The method for producing a semiconductor device according to Claim 13 ~~Claim 12~~, wherein ~~the step of forming the cylindrical portion on the side of the core and the bottom portion wherein the outer wall of the cylindrical portion is roughened,~~ ~~comprises~~ the ~~[[sequential]]~~ steps of forming the film made of ~~[[an]]~~ amorphous silicon ~~[[film]]~~ on said core and said bottom portion; roughening ~~[[an]]~~ the outer surface of said ~~amorphous silicon~~ film by forming silicon grains in the outer surface of it; and conducting an anisotropic etching for patterning to form said cylindrical portion having ~~[[a]]~~ the side-wall like shape at the side of said core and said bottom portion are sequentially carried out.